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# The Effects of a Selected Resistance Training Program on the Improvement of Arm Throwing Strength and on Selected Items of the Football Passing Performance

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THE EFFECTS OF A SELECTED RESISTANCE TRAINING PROGRAM ON THE  
IMPROVEMENT OF ARM THROWING STRENGTH AND ON SELECTED  
ITEMS OF THE FOOTBALL PASSING PERFORMANCE

BY

DEAN EUGENE KOSTER

A thesis submitted  
in partial fulfillment of the requirements for the  
degree Master of Science, Major in  
Physical Education, South Dakota  
State University

1967

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THE EFFECTS OF A SELECTED RESISTANCE TRAINING PROGRAM ON THE  
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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

\_\_\_\_\_/Thesis Adviser

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THE EFFECTS OF A SELECTED RESISTANCE TRAINING PROGRAM ON THE  
IMPROVEMENT OF ARM THROWING STRENGTH AND ON SELECTED  
ITEMS OF THE FOOTBALL PASSING PERFORMANCE  
Abstract

DEAN EUGENE KOSTER

Under the supervision of Professor Ralph Ginn

The purpose of this study was to determine the effects of a selected resistance program on the improvement of arm-throwing strength and on selected items of the football passing performance.

The following procedure was employed in this investigation. Twelve football players selected from the 1966 freshman and varsity football teams at South Dakota State University were employed as subjects. The subjects had a history of passing the football either on the high school level or during college competition. Two experimental groups were determined and equated from the results of the anterior and posterior muscular strength tests of the throwing arm. The groups were determined randomly to be the Resistance Group (Exer-Genie) and the Throwing Group (without Exer-Genie). The subjects in both groups practiced their techniques for a period of eighteen days. The subjects in the Resistance Group threw one hundred passes daily and worked with specific exercises on the

26617  
Exer-Genie. The subjects in the Throwing Group threw one hundred passes daily but did not work with the Exer-Genie.

All subjects were tested at the beginning of the investigation and immediately following completion of the training program. Throwing arm strength, passing accuracy, and the football throw for distance were investigated.

The data collected during the testing were recorded and analyzed statistically to determine what effects the selected resistance training program had on football passing performance.

The results of the findings indicated that the Resistance Group and the Throwing Group had a significant effect on increased throwing arm strength and passing accuracy. In the football throw for distance, the results indicate that the improvement of the Resistance Group was statistically significant, whereas, that of the Throwing Group was not. This result was indicated within each of the groups. However, between the two groups, no significant effect on increased throwing arm strength and the football throw for distance was found. The Resistance Group made statistically significant improvement over the Throwing Group in football passing accuracy.

## ACKNOWLEDGEMENTS

The writer wishes to express his sincere appreciation to Professor Glenn E. Robinson, Mr. Ralph A. Ginn, and Mr. William E. Fritz for their assistance throughout the course of the work reported here and the preparation of this thesis.

The interest, desire and work of the 12 subjects is gratefully appreciated.

This thesis is dedicated to my wife whose support and encouragement made this advanced study possible.

DEK

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## Chapter I

### INTRODUCTION

#### Reasons for Study

There have been many books written concerning football, and throughout the years a number of well-known coaches have published material on some phase of the game of football. Annually, coaches with great defensive teams will publish their reasons for success, and the offensive coaches of the year will capitalize on their good fortune by circulating their ideas to other coaches through the written page. Off-season training programs often appear in the writings of coaches as a factor of success. Gillman and Roy<sup>1</sup> state detailed analyses of their training

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<sup>1</sup>Sid Gillman and Alvin Roy, Strength Program.

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programs for football players. Murray and Karpovich<sup>2</sup>

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<sup>2</sup>Jim Murray and Peter V. Karpovich, Weight Training in Athletics, pp. 114-122.

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talk about the application of different weight training programs for most athletic events. Hooks<sup>3</sup> relates to

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<sup>3</sup>Gene Hooks, Application of Weight Training to Athletics, pp. 156-178.

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coaches his ideas of the use of weight training as applied to athletic training.

However, investigation reveals that very little material has been written on an off-season training program for quarterbacks. Great quarterbacks, such as Luckman<sup>4</sup> and Graham,<sup>5</sup> have published books about

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<sup>4</sup>Sid Luckman, Luckman at Quarterback, p. 90.

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<sup>5</sup>Otto Graham, "T" Quarterback, p. 171.

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quarterbacking football teams. These men have written about their own experiences as quarterbacks on university and professional teams and mention the qualities that are essential to be a great quarterback. Coolness in execution, intelligence in signal calling, and superiority in pass protection are given as primary reasons for their success. The writers agree that there are other contributing factors such as a sense of timing, peripheral vision, grip of ball, and release of ball.

#### Statement of Problem

The purpose of this study was to determine the effects of a selected resistance training program on the

improvement of arm-throwing strength and on selected items of the football passing performance.

### Need for Study

The forward pass is an important phase of football. New training programs to develop arm-throwing strength, accuracy, and speed are constantly being sought by the football coach. It is a common error of many passers to "hang" the ball in the air instead of hitting the target or receiver quickly and accurately. The failure of the passer to hit his target quickly and accurately along with the speed, size, and quickness of pass defenders leads to many intercepted passes. Football coaches know that the bane of a passer's existence is the interception.

### Limitations of Study

1. This study was limited to selected football players of the 1966 South Dakota State University varsity and freshman teams.
2. The study was conducted in an enclosed area.
3. Accuracy was considered only to the extent that the ball penetrated the scoring area of a target.
4. No center snap was used. The subjects began the throwing act with the football at chest position.

5. The subject's desire to excel was not taken into consideration. No motivational factors were employed.

6. Instructions were given only on the grip of the football and on the act of delivery.

### Definitions of Terms

#### Overhand Grip

The definition of the overhand grip as expressed by Van Brocklin<sup>6</sup> was accepted for this study.

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<sup>6</sup>Norm Van Brocklin, Norm Van Brocklin's Football Book, pp. 9-26.

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The little finger is placed on the third horizontal lacing with the middle finger approximately an inch directly above the ring finger. The index finger takes a wider spread than the other fingers and at more of an angle so that it almost touches the point of the ball. The thumb almost makes a right angle to the index finger and rests on the underside of the ball. The index finger is the controlling factor and should be the last finger to "feel" leather as the ball is released.

#### Delivery of the Ball (from behind the ear)

The definition for the delivery of the ball as expressed by Van Brocklin<sup>7</sup> was accepted for this study.

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<sup>7</sup>Ibid.

---

The arm and hand are cocked backwards over the shoulder, elbow relatively close to the body, hand well back to where it feels comfortable and natural. Then fire the ball forward as fast as you can. While delivering the ball, exaggerate throwing the elbow out in front of the body so that the point of the ball will stay up and therefore, carry farther. In releasing the ball, draw the fingers and the hand inward and downward. This should provide the spiral flight so necessary to a well-thrown ball.

### Progressive Resistance Exercise

Progressive resistance exercise refers to an exercise which aims to develop strength by forcing the skeletal muscles to contract against resistance. The resistance should be maximal and the number of repetition, few.<sup>8</sup>

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<sup>8</sup>Murray and Karpovich, op. cit., p. 72.

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### Agonist or Agonistic Muscles

Agonist or agonistic muscles refer to a muscle group which is directly responsible for effecting a movement.<sup>9</sup>

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<sup>9</sup>Catherine F. Wells, Kinesology, p. 74.

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### Antagonist or Antagonistic Muscles

Antagonist or antagonistic muscles refer to a muscle group which causes the opposite movement from that of the muscle group acting as an agonist.<sup>10</sup>

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<sup>10</sup>Ibid., p. 76.

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### Anterior Muscle Group

Anterior muscle group refers to those muscle groups which act as agonist in a given movement.

### Posterior Muscle Group

Posterior muscle group refers to those muscle groups which act as antagonist in a given movement.

### Isometric Contraction

Isometric contraction is a contraction in which a muscle is unable to shorten. No movement is produced and no work is performed.

### Isotonic Contraction

Isotonic contraction is a contraction in which a muscle shortens against a load, resulting in movement and the performance of work.

Exer-Genie

Exer-Genie, manufactured by Exer-Genie Incorporated, Fullerton, California, is a commercial resistance device used to create the force for the resistance throwing group to pull against.



## Chapter II

### REVIEW OF RELATED STUDIES

#### Introduction

The review of literature was confined to research concerning strength development and to other characteristics of a football quarterback.

#### Report of Pertinent Findings

Since the first game of intercollegiate football between Princeton and Rutgers Universities, November 6, 1869, there have been volumes of written material published pertaining to the game of football.<sup>11</sup>

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<sup>11</sup> J. M. Tatum and W. K. Giese, Coaching Football and the Split "T" Formation, p. 3.

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The sports writers must have found football more colorful and interesting to write about after Harry Williams in 1906 fought successfully to have the Rules Committee legalize the forward pass.<sup>12</sup> However, the

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<sup>12</sup> ibid., p. 11.

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professional writer does not concern himself with the more technical methods for individual improvement of the passing performance.

The forward pass has become more and more a football way of life. Over the years, the game of football has moved in different directions and has taken many trends.

With today's modern offensive thinking, offenses are geared basically around two types of personnel: The first group being the quick, aggressive, and agile linemen; the other group being the skilled runners, kickers, receivers, and passers. Tom Pagna,<sup>13</sup> assistant football

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<sup>13</sup>Tom Pagna, "Developing a Quarterback," American Football Coaches Association, pp. 36-39.

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coach, University of Notre Dame, states: "Of all of these requirements, the quarterback in the 'T' offense is probably the boy most needful of what I like to call 'skills.'" Some traits that a good quarterback must have are speed, quickness (quick hands and feet), and agility. It is essential that a good quarterback must be able to throw. This ability does not mean the mechanically perfect motion of a classic, but the quarterback must have a strong arm, innate perception, and speed in his delivery.

Nitchman<sup>14</sup> states that a poised, accurate passer

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<sup>14</sup>Nelson W. Nitchman, "The Well Balanced Passing Attack," American Football Coaches Association, p. 9.

---

with sound and determined protection ahead of him and

fast, agile, deceptive, and adept receivers are the ingredients which go to make up a desirable type of passing game. In a prefatory way it might be advisable to mention a few drills which have been important factors in improving each of these phases of the passing game. The investigator likened each passer to a baseball catcher and emphasized the high release of the ball, laying heavy stress on (1) that the thrower should not turn his wrist as he throws the ball, (2) that he should not drop the wrist after actual release of the ball, and (3) that on the longer type pass the ball must be held and released from a higher plane than on the shorter throws.

With the recent rule changes allowing greater liberalization of the substitution rule, there is a trend back toward platoon football. Offensive thinking has started to change drastically with offensive and defensive teams being used again. The last year or two have seen more wide formations with split-ends and/or flanker-backs. The current trend is toward wide open football, and the forward pass and its various aspects have become a prominent feature of the offensive patterns of many of the leading teams throughout the nation. With the use of wide formations, the quarterback with a strong accurate arm is becoming a necessity.

Various studies have brought out the fact that there is a high relationship between resistance exercises and increased muscular power and strength.

Masley<sup>15</sup> stated the fact that with the increased

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<sup>15</sup>J. W. Masley, Ara Hairbedian, and D. N. Donaldson, "Weight Training in Relation to Strength, Speed, and Coordination," Research Quarterly, October, 1953, pp. 16-20.

---

strength gain by weight training there was an improved associated muscular coordination and an increased speed of movement.

Zorbas and Karpovich<sup>16</sup> reported that weight

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<sup>16</sup>W. S. Zorbas, and P. V. Karpovich, "The Effect of Weight Lifting Upon the Speed of Muscular Contractions," Research Quarterly, May, 1951, pp. 145-148.

---

training increases the speed of rotary motions of the arm.

Capan<sup>17</sup> studied four training programs which

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<sup>17</sup>Edward K. Capan, "Study of Four Programs of Heavy Resistance Exercise for Development of Muscular Strength," Research Quarterly, May, 1958, pp. 132-142.

---

practiced three and five days weekly to determine which of the programs proved superior in the development of strength. He discovered that the program which included

five executions of maximum weight that could be lifted for three sets practiced three times a week was the superior method.

Capan<sup>18</sup> found that weight training did not

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<sup>18</sup>Ibid.

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result in muscular tightness nor did it affect speed. From tests of flexibility and weight training, Capan<sup>19</sup>

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<sup>19</sup>Ibid.

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concluded that there was no loss of range of movement from a weight-training program.

DeVries<sup>20</sup> in his text states that isometric and

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<sup>20</sup>Herbert A. deVries, Physiology of Exercise for Physical Education and Athletics, pp. 307-309.

---

isotonic methods have been shown to bring about significant gains in strength in short periods of time, but in investigations where direct comparisons have been made the differences, although not large, favor the isotonic method.

Probably the greatest advantage in isotonic methods is that strength gains are specific to the angle at which the resistance is encountered. Thus isotonic exercises can be designed to work the entire range of

motion in one contraction, but several contractions would be needed at different angles to work the whole range of motion with isometric methods.

Another advantage for isotonic methods may be that the individual sees work being done, and this experience appears to be a psychological advantage for those who find a static contraction boring.

In the isometric pull the chief advantages are administrative in nature. If only one contraction per day is used, great savings in time are possible. Furthermore, a little ingenuity can reduce the equipment needed to pieces of apparatus that are already available in the gym or on the practice field.

Pitchford and Hamilton<sup>21</sup> discussed the

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<sup>21</sup> Keith Pitchford and Paul "Rusty" Hamilton, "Isometrics Are for Tennis Too," Athletic Journal, February, 1965, p. 36.

---

advantages of both the isometric and isotonic pull in their study. Force was applied at the start of movement, at the center of the movement, and finally at the point of release of the ball. An isotonic pull, in which maximum weight was pulled, took place between each of these three isometric points.

The pamphlet Exer-Genie Exerciser<sup>22</sup> states the

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<sup>22</sup>Exer-Genie Exerciser, pamphlet, "It's Fun to Get Fit With Exer-Genie Exerciser," Advertisement by Exer-Genie, Inc., Fullerton, California, 1966.

---

following:

Exer-Genie combines the latest theories in resistive exercise. By starting each exercise isometrically we get the great strength benefits of this new school of exercise and by combining it with isotonic movement, we get the benefits of endurance and flexibility. Time is saved because by starting the exercise isometrically we are working a tired muscle when we start our movement and this enables us to cut the needless repetition of movements.

By working against resistance, the athlete is actually working in slow motion which permits the coach to study his form in detail. At the same time, the athlete is building muscles used in his particular sport or event as well as increasing stamina, endurance, flexibility, and technique.

#### Summary

The related literature seems to be in agreement that strength and accuracy of the throwing arm are important factors in becoming a football quarterback. The literature also appears to be in agreement that the most efficient method to develop strength is to work

against resistance greater than that to which the body is accustomed and to duplicate the exact motion of the skill that the individual is working to develop.

The literature tends to indicate a direct relationship between the individual's power, his strength, and his speed. Also, the literature seems to agree that power can best be developed by duplicating, against resistance, the exact movements that the individual needs to make in competition.



### Chapter III

#### PROCEDURE FOR OBTAINING DATA

##### Introduction

The procedures that were employed in obtaining the data and the description of the subjects in the experiment are described in this chapter.

##### Subjects

Twelve football players selected from the 1966 freshman and varsity football teams at South Dakota State University were employed as subjects. The twelve selected subjects had a history of passing the football either on the high school level or during college competition.

Following the investigator's search of literature and consultation with his advisors, the anterior and posterior muscular strength tests of the throwing arm were selected as tests to be employed in equating the groups included in the study. (Figure 1 illustrates the anterior muscular strength test). (Figure 2 illustrates the posterior muscular strength test). The anterior and posterior muscular strength tests of the throwing arm are described in Appendix A.

Following completion of the anterior and posterior muscular strength test, the investigator totaled

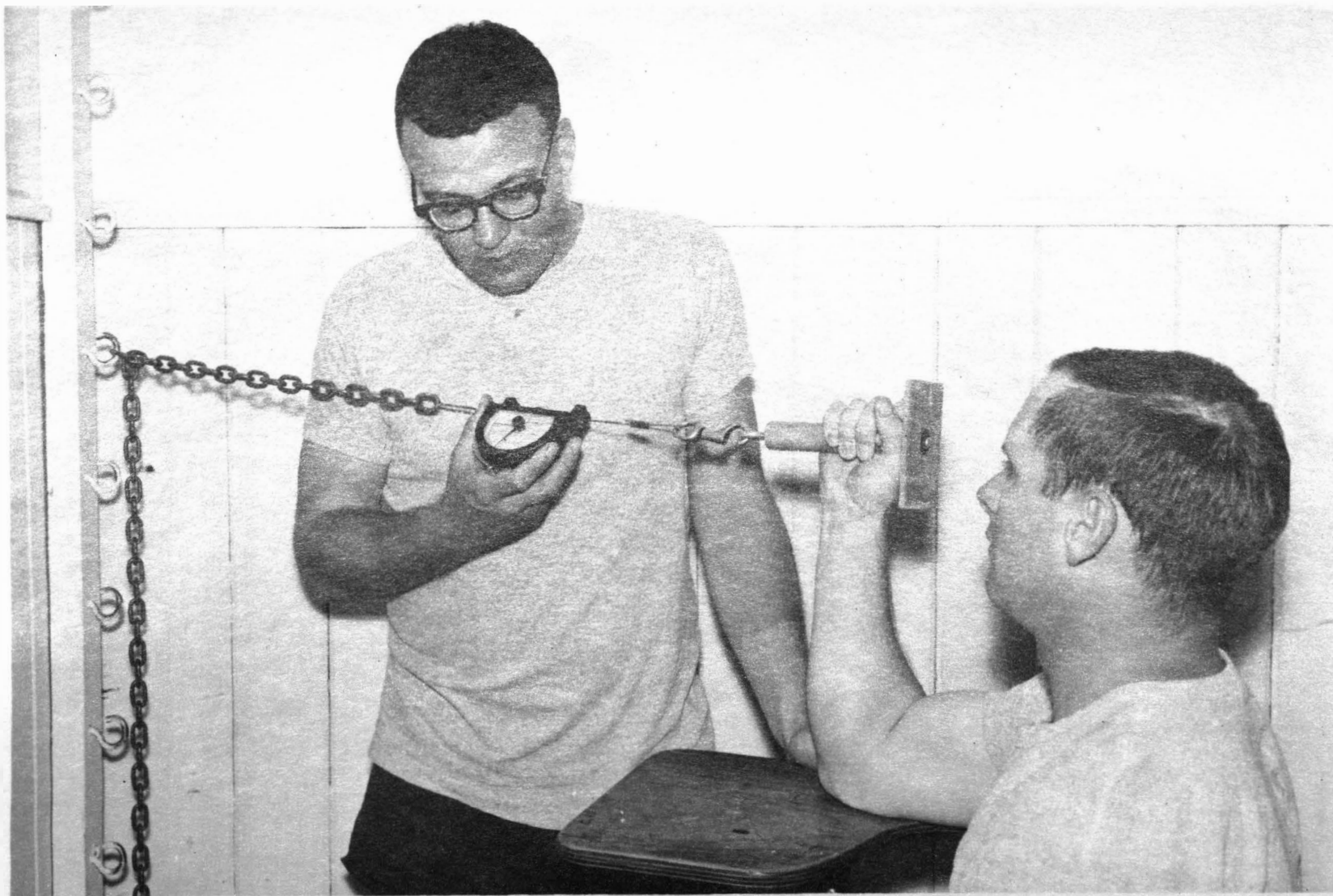


Figure 1. Anterior Muscular Strength Test

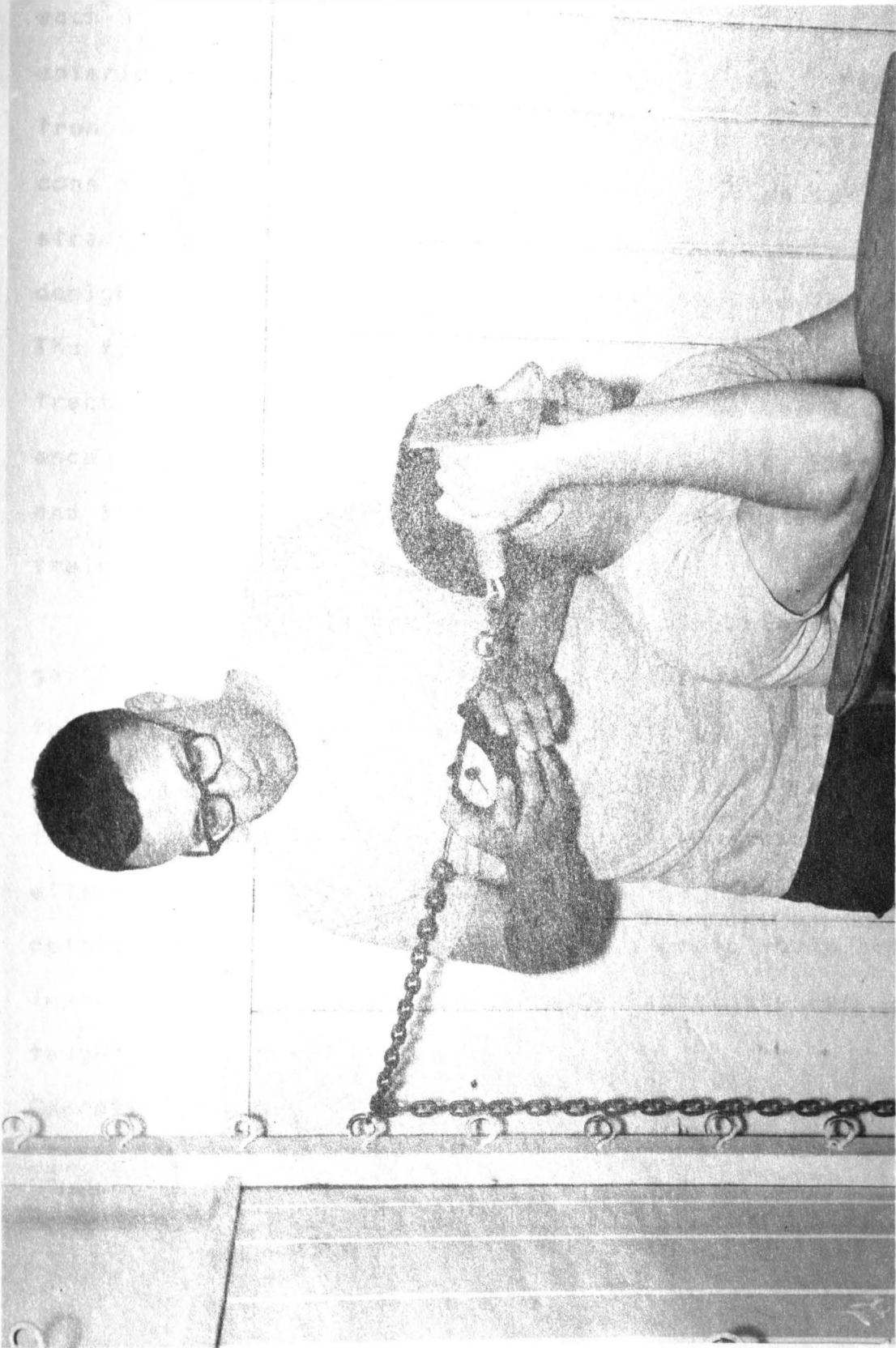


Figure 2. Posterior Muscular Strength Test

each subject's posterior muscular strength pull and anterior muscular strength pull and ranked them in order from highest to lowest. To form two equated groups each consisting of six subjects, the anterior and posterior strength pull data were utilized. The groups were designated as the Resistance Group and the Throwing Group. The function of each group was determined randomly by the track pillbox method. The random choice for the Resistance Group was a training program employing the Exer-Genie, and the random choice for the Throwing Group was the training program without the Exer-Genie.

No control group was employed in this investigation. In this investigation the principal concern was to determine how well one experimental group achieved over another experimental group when two different teaching techniques were employed. The control group was eliminated from this study because in the investigator's opinion it must be assumed that such a group would not improve in passing technique if such techniques were not taught to a control group.

Garrett<sup>23</sup> states,

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<sup>23</sup>Henry E. Garrett, Elementary Statistics, p. 117.

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In testing an hypothesis, one of several experimental factors or independent variables are tried out at various strengths in the different experimental groups; and the net effect of these factors upon behavior are checked against their absence in a control group.

### Instruments for Obtaining Data

It was necessary to establish the level of performance for each subject, before the training period began, in anterior-posterior muscular strength and the football throw for accuracy and distance. A cable tensiometer was used to determine the strength factor, the American Association for Health Physical Education and Recreation football throw for accuracy test to indicate accuracy, and the AAHPER football throw for distance test to show distance. These three techniques, used to establish performance levels at the onset of the experiment, were also used at the conclusion of the experiment.

#### Cable Tensiometer

The cable tensiometer was employed to determine the strength of the agonistic and antagonistic muscles used in throwing. It is an instrument designed to measure the tension of aircraft cable. Cable tension is determined from the force needed to create offset on a riser in a cable stretched between two set points, or sectors.

This tension can be converted on a calibration chart into pounds pulled. The cable tensiometers were calibrated by the Civil Engineering Department of South Dakota State University.

As reflected by objectivity coefficients, the tensiometer has great precision for strength testing (.90 and above). It is the most stable and generally useful of all strength testing instruments.<sup>24</sup>

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<sup>24</sup>H. Harrison Clarke, Application of Measurement to Health and Physical Education, pp. 178-179.

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#### Targets for Football Throwing Accuracy

Portable targets were erected in the enclosed area. They were constructed according to specification as outlined in the AAHPER<sup>25</sup> skills test manual for 1965.

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<sup>25</sup>American Association for Health Physical Education and Recreation, Skills Test Manual, p. 23.

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A diagram of these targets is found in Appendix B.

#### Instruments Used for Football Throw for Distance

The AAHPER<sup>26</sup> football throw for distance was

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<sup>26</sup>Ibid., p. 17.

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also used in this investigation. A sports field with

marked throwing lane, standard football, and measuring tape were other equipment items used.

### Training Program

The study involved the teaching of and the learning of techniques; therefore, the investigator attempted to gear his program to take into consideration Thorndike's laws of learning. Vannier<sup>27</sup> instructs that

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<sup>27</sup>Maryhellen Vannier, Teaching Physical Education in Secondary Schools, p. 40.

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"Thorndike's three famous laws of learning will, if properly applied by the teacher, increase both the scope and depth of pupil learning. These include: (1) The Law of Readiness, (2) The Law of Exercise, and (3) The Law of Effect."

The subjects in the Resistance Group and in the Throwing Group participated in the training program three times per week for a total of eighteen sessions, using the program designed for their group. One week, before the training program started, was spent in the teaching of throwing technique, proper use of the Exer-Genie for the investigator's study, and drills to improve passing performance.

Throughout the entire program, the subjects in the Resistance Group and the Throwing Group threw 100



times each session. The total score of each subject was recorded and used as the basis for a daily learning curve for each group.

The 100 throws thrown each session were thrown from different angles. These angles and distances were determined by the coaching staff of South Dakota State University as being the ones most commonly used in designing pass routes for receivers.

The subjects threw 20 passes on a straight ahead pattern, 40 passes on a break pattern, and 40 passes on a cross pattern. All pass patterns employed and placement of targets are found in Appendix C.

After throwing 100 times each session, the Resistance Group would then work in the following manner with the Exer-Genie.

The same techniques were used in the training program as were employed in the pre-test of the anterior-posterior muscular strength tests. However, an Exer-Genie and handle were attached to the wall instead of a wire cable.

In strengthening the anterior muscles of the throwing arm, the subject sat in a chair facing the wall. The subject completed an isometric exercise for seven seconds at the point of release of the ball and then an isotonic exercise pulling maximum force to the point where



his elbow formed a 90-degree angle. With the elbow in this position, the subject did another isometric exercise for seven seconds and then an isotonic exercise pulling maximum force until the arm was back as far as possible. (See Figure 1 and note Exer-Genie replaces the wire cable).

To strengthen the posterior muscles of the throwing arm, the subject's throwing arm was pulled back as far as possible. With the arm in this position, the subject did an isometric exercise for seven seconds and then an isotonic exercise pulling maximum force to the point where the elbow joint formed a 90-degree angle. At this point the subject completed another isometric exercise for seven seconds and then an isotonic exercise pulling maximum force to the point of release of the ball. (See Figure 3, and note the use of Exer-Genie). Three repetitions of anterior and posterior exercises were done each session.

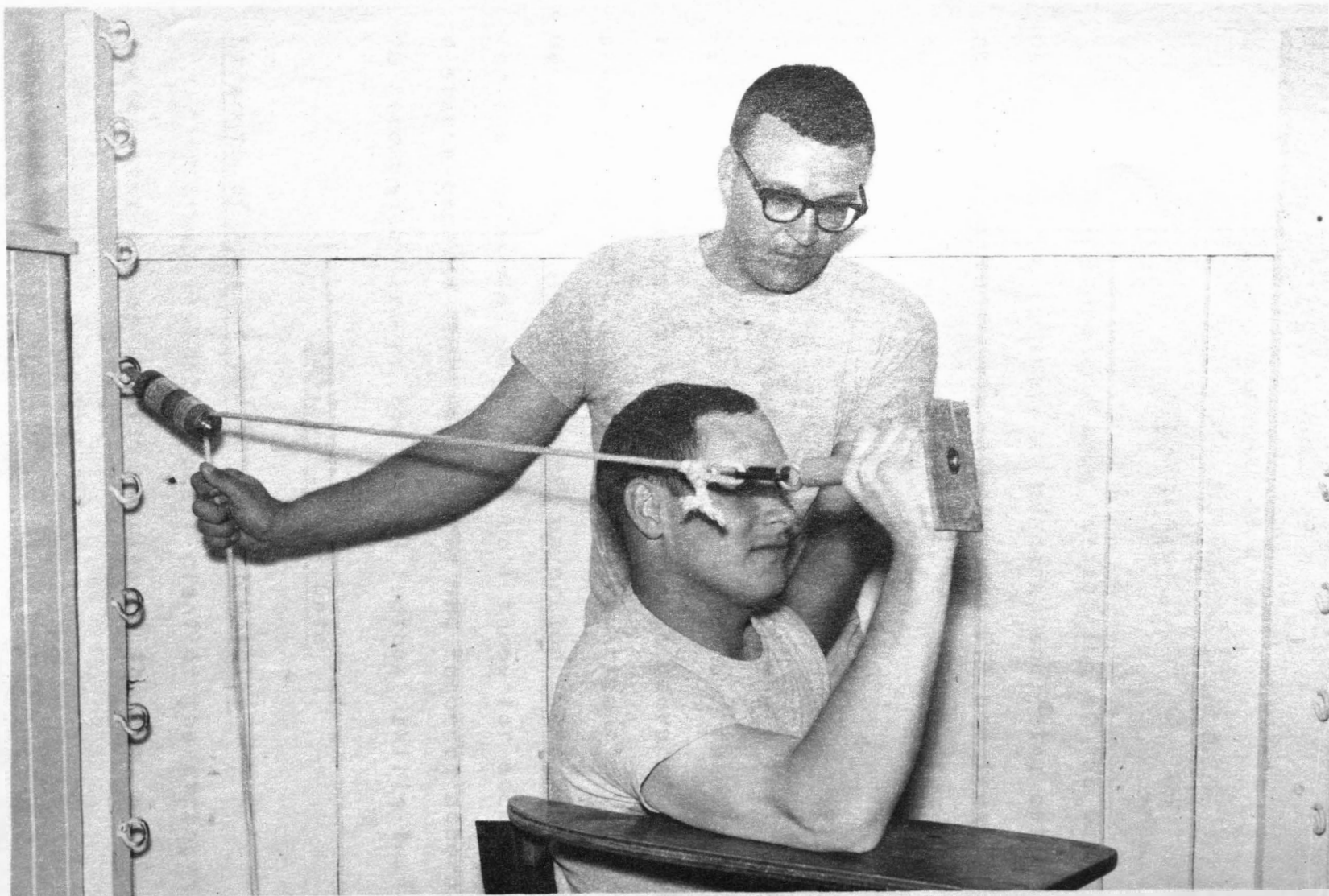


Figure 3. Resistance Throwing Apparatus

## Chapter IV

### ANALYSIS OF DATA

#### Introduction

The procedure used for scoring of the data, determining the reliability of data, analyzing data, (The raw data appears in Appendixes D and E.) and treating the data is described in this chapter.

#### Scoring of Data

The raw scores on the arm strength test were recorded in uncorrected tension pounds and then converted to actual pounds pulled by employing a conversion table prepared by the Civil Engineering Department of South Dakota State University. No conversions were necessary for the raw scores of the football throw for accuracy and distance because they were scored and recorded according to recommendations of the AAHPER football skills test.

#### Reliability of Data

##### Strength of Agonist and Antagonist Muscles

The reliability coefficient of the strength of the agonist and antagonist muscles of the arm, as

established by Barrow<sup>28</sup> through the test-retest method

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<sup>28</sup>Robert Arthur Barrow, "Effect of Strength Development of Antagonistic Muscles on Throwing Performance," Master of Science Thesis, University of Oregon, 1957, p. 25.

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indicated a correlation of +.77.

#### Football Throw for Accuracy

The reliability coefficient of the AAHPER football throw for accuracy<sup>29</sup> was found to be between

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<sup>29</sup>American Association for Health Physical Education and Recreation, Football Skills Test Manual, pp. 22-23.

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+ .70 to + .80.

#### Football Throw for Accuracy

The reliability coefficient of the AAHPER football throw for distance<sup>30</sup> is greater than +.80.

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<sup>30</sup>Ibid., p. 17.

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#### Analysis of Data

The analysis of data for this investigation dealt statistically with the mean gain or loss difference between the two experimental groups. Statistical procedures were also applied to the mean gain or loss difference between the initial and final tests within

each of the two experimental groups. The investigator employed the  $t$  test as suggested by Garrett<sup>31</sup> to

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<sup>31</sup> Henry E. Garrett, Elementary Statistics, pp. 116-138.

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determine the critical ratio ( $t$  ratio). The .05 level of significance was chosen and 10 degrees of freedom between groups and 5 degrees of freedom within groups were present in this investigation. The null hypothesis was rejected if the  $t$  ratio obtained was equal to or greater than 2.23 between groups and 2.57 within groups.

### Findings

Table I shows the significance of the difference between means of the two experimental groups on all test items.

#### Throwing Arm Strength

The mean gain of the Resistance Group was 21.83 pounds. The mean gain of the Throwing Group was 8.00 pounds. The  $t$  ratio between the Resistance Group and the Throwing Group was calculated to be 1.84; this was not significant at the .05 level of significance. The null hypothesis was accepted.

Table I

Summary of  $t$  Test for Difference Between Means  
for the Two Experimental Groups

	Initial Mean	Final Mean	Mean Gain or Loss	SE <sub>D</sub>	$t$ Ratio
<u>Throwing Arm Strength (pounds)</u>					
Resistance Group	108.50	130.33	+21.83	7.62	1.84
Throwing Group	108.33	116.33	+ 8.00		
<u>Football Throw for Accuracy (points)</u>					
Resistance Group	135.66	195.66	+60.00	9.97	3.69*
Throwing Group	128.83	158.83	+30.00		
<u>Football Throw for Distance (feet)</u>					
Resistance Group	140.83	152.00	+11.17	5.09	.68
Throwing Group	150.50	155.50	+ 5.00		

\* Statistically significant beyond .01 level.

### Football Throw for Accuracy

The mean increase in accuracy of throwing of the Resistance Group was 60.00 points. The mean gain of the Throwing Group was 30.00 points. The  $t$  ratio between the Resistance Group and the Throwing Group was calculated to be 3.69; this was statistically significant beyond the .01 level of significance. The null hypothesis was rejected.

### Football Throw for Distance

The mean gain of the Resistance Group was 11.17 feet. The mean gain of the Throwing Group was 5.00 feet. The  $t$  ratio between the Resistance Group and the Throwing Group was calculated to be .68; this was not statistically significant at the .05 level of significance. The null hypothesis was accepted.

Table II shows the significance of the difference between means within the Resistance Group on all test items.

### Throwing Arm Strength

The mean gain within the Resistance Group was 21.83 pounds. The  $t$  ratio between the initial and final tests was calculated to be 6.72; this was statistically significant beyond the .01 level of significance. The null hypothesis was rejected.

Table II

Summary of  $\pm$  Test for Difference Between  
Means Within the Resistance Group

	Initial Mean	Final Mean	Mean Gain or Loss	SE <sub>md</sub>	$\pm$ Ratio
<u>Throwing Arm</u> <u>Strength</u> (pounds)					
Resistance Group	108.50	130.33	+21.83	3.25	6.72*
<u>Football Throw</u> <u>for Accuracy</u> (points)					
Resistance Group	135.66	195.66	+60.00	5.15	11.65*
<u>Football Throw</u> <u>for Distance</u> (feet)					
Resistance Group	140.83	152.00	+11.17	2.86	3.85**

\* Statistically significant beyond .01 level.

\*\* Statistically significant beyond .05 level.



### Football Throw for Accuracy

The mean increase in accuracy of throwing within the Resistance Group was 60.00 points. The  $t$  ratio between the initial and final tests was calculated to be 11.65; this was statistically significant beyond the .01 level of significance. The null hypothesis was rejected.

### Football Throw for Distance

The mean gain within the Resistance Group was 11.17 feet. The  $t$  ratio between the initial and final tests was calculated to be 3.85; this was statistically significant beyond the .05 level of significance. The null hypothesis was rejected.

Table III shows the significance of the difference between means within the Throwing Group.

### Throwing Arm Strength

The mean gain within the Throwing Group was 8.00 pounds. The  $t$  ratio between the initial and final test was calculated to be 3.57; this was statistically significant beyond the .05 level of significance. The null hypothesis was rejected.

### Football Throw for Accuracy

The mean gain in accuracy of throwing within the Throwing Group was 30.00 points. The  $t$  ratio between

Table III

Summary of  $t$  Test for Difference Between  
Means Within the Throwing Group

	Initial Mean	Final Mean	Mean Gain or Loss	SE <sub>md</sub>	$t$ Ratio
<u>Throwing Arm Strength (pounds)</u>					
Throwing Group	108.33	116.33	+ 8.00	2.80	3.57**
<u>Football Throw for Accuracy (points)</u>					
Throwing Group	128.83	158.83	+30.00	3.67	8.17*
<u>Football Throw for Distance (feet)</u>					
Throwing Group	150.50	155.50	+ 5.00	2.18	2.29

\* Statistically significant beyond .01 level.

\*\* Statistically significant beyond .05 level.

the initial and final tests was calculated to be 8.17; this was statistically significant beyond the .01 level of significance. The null hypothesis was rejected.

#### Football Throw for Distance

The mean gain within the Throwing Group was 5.00 feet. The  $t$  ratio between the initial and final tests was calculated to be 2.29. The null hypothesis was accepted.

#### Learning Curve

A learning curve was plotted daily for the passing accuracy of each of the two experimental groups. The Resistance Group (Figure 4) had a mean average of 125 points for the first day. The Resistance Group had a mean average of 198 points for the final testing day. The minimum score for the Resistance Group was reached on the first day (125 points), and the maximum score was reached on the fourteenth day (205 points).

The Throwing Group (Figure 5) had a mean average of 110 points for the first day. The Throwing Group had a mean average of 166 points for the final testing day. The minimum score for the Throwing Group was reached on the first day (110 points), and the maximum score was reached on the sixteenth day (167 points).

The learning curve indicates that the Resistance Group increased more rapidly but then leveled off the last

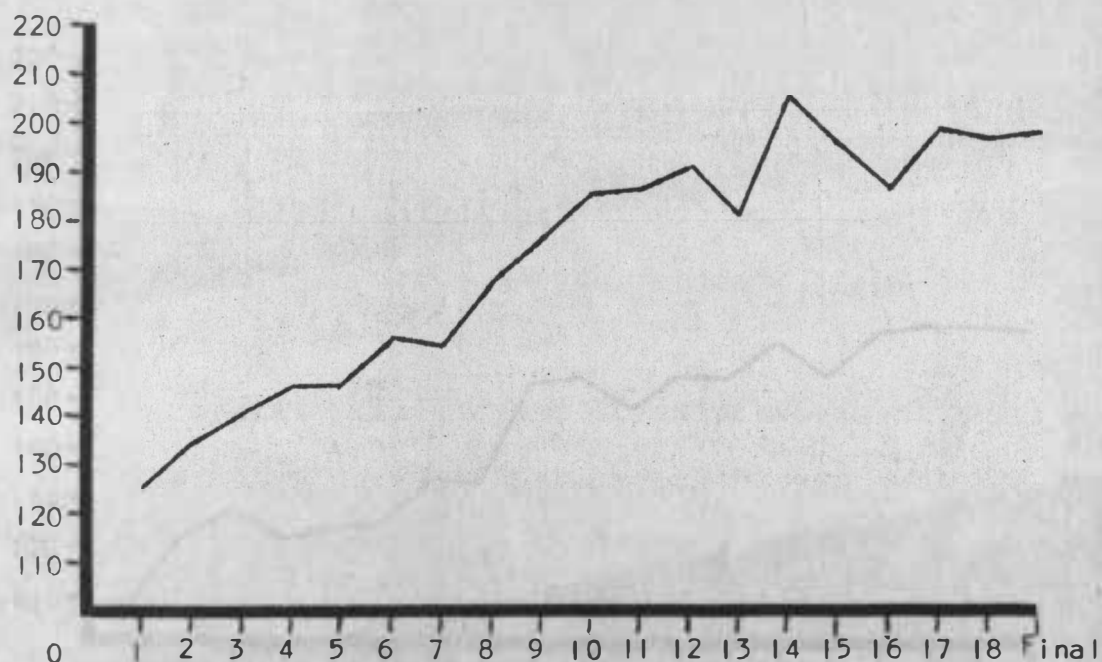


Figure 4

Football passing accuracy learning curve for the group that worked with the Exer-Genie. The ordinate represents the mean of the group's passing accuracy performance, and the abscissa represents the eighteen sessions of the training period and the final testing day.

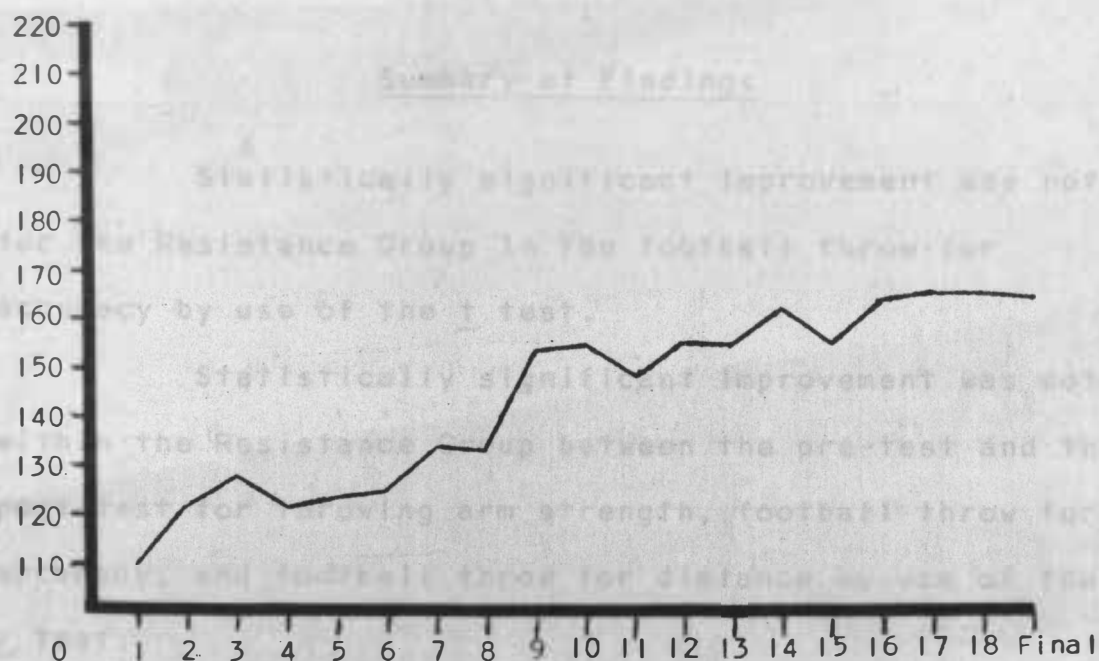


Figure 5

Football passing accuracy learning curve for the group that did not work with the Exer-Genie. The ordinate represents the mean of the group's passing accuracy performance, and the abscissa represents the eighteen sessions of the training period and the final testing day.

two weeks. The Throwing Group showed a more gradual increase and was not as consistent in its improvement of accuracy from day to day.

### Summary of Findings

Statistically significant improvement was noted for the Resistance Group in the football throw for accuracy by use of the  $t$  test.

Statistically significant improvement was noted within the Resistance Group between the pre-test and the post-test for throwing arm strength, football throw for accuracy, and football throw for distance by use of the  $t$  test.

Statistically significant improvement was noted within the Throwing Group, between the pre-test and the post-test for throwing arm strength and football throw for accuracy by use of the  $t$  test.

### Discussion of Findings

The statistically significant improvement, as noted within the Resistance Group for increased throwing arm strength and increased distance in throwing the football, was the result that would be expected. Similar results have been reported in the literature for this type of training program.

The statistically significant improvement noted within the Throwing Group for increased throwing arm strength and increased football throwing accuracy were also results that would be expected.

The writer felt that the Throwing Group did not show as great as statistically significant improvement for the football throw for distance because their throwing arm strength, although it was statistically significant, was not that great compared to the Resistance Group.

The greater statistically significant improvement for the football throw for accuracy, as shown by the Resistance Group when compared to the Throwing Group, illustrates how important arm strength is in passing the football.

## Chapter V

### SUMMARY

#### Problem

The purpose of this investigation was to determine the effects of a selected resistance training program on the improvement of arm throwing strength and on selected items of the football passing performance.

#### Data

The subjects in this study were twelve football players selected from the 1966 freshman and varsity football teams at South Dakota State University. The subjects participated in a six-week training program. The training sessions for the Resistance Group included throwing the football 100 times at the AAHPER football passing target from various angles. This was followed with three resistant pulls, using the Exer-Genie, of the throwing arm's agonist and antagonist muscles. The Throwing Group's training session consisted of throwing 100 times at the AAHPER target from various angles.

Three tests--arm strength (combination of agonist and antagonist), football throw for accuracy and football throw for distance--were administered to the



two experimental groups at the beginning and at the end of the six-week training program.

The data employed in the statistical procedures were recorded in actual pounds for the arm strength test, in points for the football throw for accuracy, and in feet for the football throw for distance. The data were statistically treated to determine the effects of a selected resistance training program on the improvement of arm throwing strength and on selected items of the football passing performance. Data between the two experimental groups and within each group were treated statistically.

### Findings

#### Between the Two Experimental Groups

In the throwing arm strength test, the mean scores of the Resistance Group increased; the mean scores of the Throwing Group also increased. The difference between the mean increase of the Resistance Group and the mean increase of the Throwing Group was not significant at the .05 level of significance.

In the football throw for accuracy test, the mean scores of the Resistance Group increased; the mean scores of the Throwing Group also increased. The difference between the mean increase of the Resistance

Group and the mean increase of the Throwing Group was statistically significant at the .01 level of significance.

In the football throw for distance test, the mean scores of the Resistance Group increased; the mean scores of the Throwing Group also increased. The difference between the mean increase of the Resistance Group and the mean increase of the Throwing Group was not statistically significant at the .05 level of significance.

#### Within Experimental Resistance Group

In the throwing arm strength test, the mean scores of the Resistance Group increased. The difference between the mean increase of the initial and final tests was statistically significant at the .01 level of significance.

In the football throw for accuracy test, the mean scores of the Resistance Group increased. The difference between the mean increase of the initial and final tests was statistically significant at the .01 level of significance.

In the football throw for distance test, the mean scores of the Resistance Group increased. The difference between the mean increase of the initial and final tests was statistically significant at the .05 level of significance.

### Within Experimental Throwing Group

In the throwing arm strength test, the mean scores of the Throwing Group increased. The difference between the mean increase of the initial and final tests was statistically significant at the .05 level of significance.

In the football throw for accuracy test, the mean scores of the Throwing Group increased. The difference between the mean increase of the initial and final tests was statistically significant at the .01 level of significance.

In the football throw for distance test, the mean scores of the Throwing Group increased. The difference between the mean increase of the initial and final tests was not statistically significant at the .05 level of significance.

### Conclusion

From the findings of this investigation, the following conclusions were drawn:

That a selected resistance training program along with throwing appears to be a more effective method of increasing throwing arm strength, throwing accuracy, and throwing distance than simply throwing.

That increased arm strength will improve selected items of the football passing performance.

#### Recommendations for Further Study

The following are the investigator's recommendations for possible future study in the area of resistance training programs:

1. That a similar study be undertaken for a longer period of time, lengthening the resistance training program to eight or ten weeks.
2. That a similar study be completed employing a larger sample.
3. That a similar study be completed, including only quarterbacks with one or more years of college experience.
4. That a similar study be repeated during the football season to determine what effects a resistance training program has on the athletes at this time.

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## Appendix A

### DESCRIPTION AND ADMINISTRATION OF ANTERIOR AND POSTERIOR MUSCULAR STRENGTH TEST

In this study, one end of a cable was attached to the wall by a wall hook; the other was attached to a handle. The cable tensiometer was clamped on the cable. The subject sat up straight against the back of an arm chair which could be adjusted closer or farther away from the wall as the length of the arm of each varied. The arm rest also could be adjusted to the size of the subjects.

#### Posterior Muscular Strength Test

To test the posterior muscular strength of the throwing arm, the arm used in throwing was put on the arm rest so that the humerus bone was parallel to the floor. The elbow joint was put in a position of a 90-degree angle. The position was standardized for each subject.

Movement was limited to the arm and shoulder girdle, with body lean or twist not being allowed. Three trials were given, the best trial being recorded as the performance score for each subject.

#### Anterior Muscular Strength Test

To measure the anterior muscular strength of the throwing arm, the chair was turned around so that the

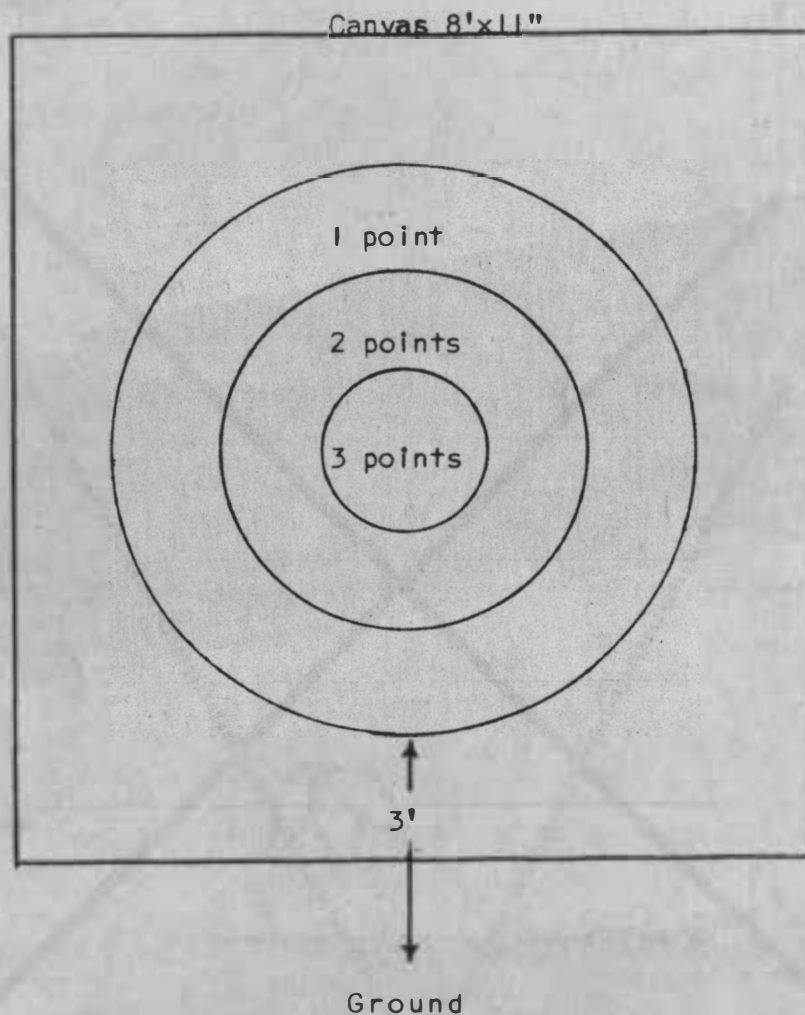


subject sat facing the wall. The subject's body position remained the same. However, the subject pulled backwards instead of forward this time. Three trials were given and the best trial was recorded as his performance score.



## Appendix B

AMERICAN ASSOCIATION FOR HEALTH PHYSICAL  
EDUCATION AND RECREATION FOOTBALL  
PASSING TARGET



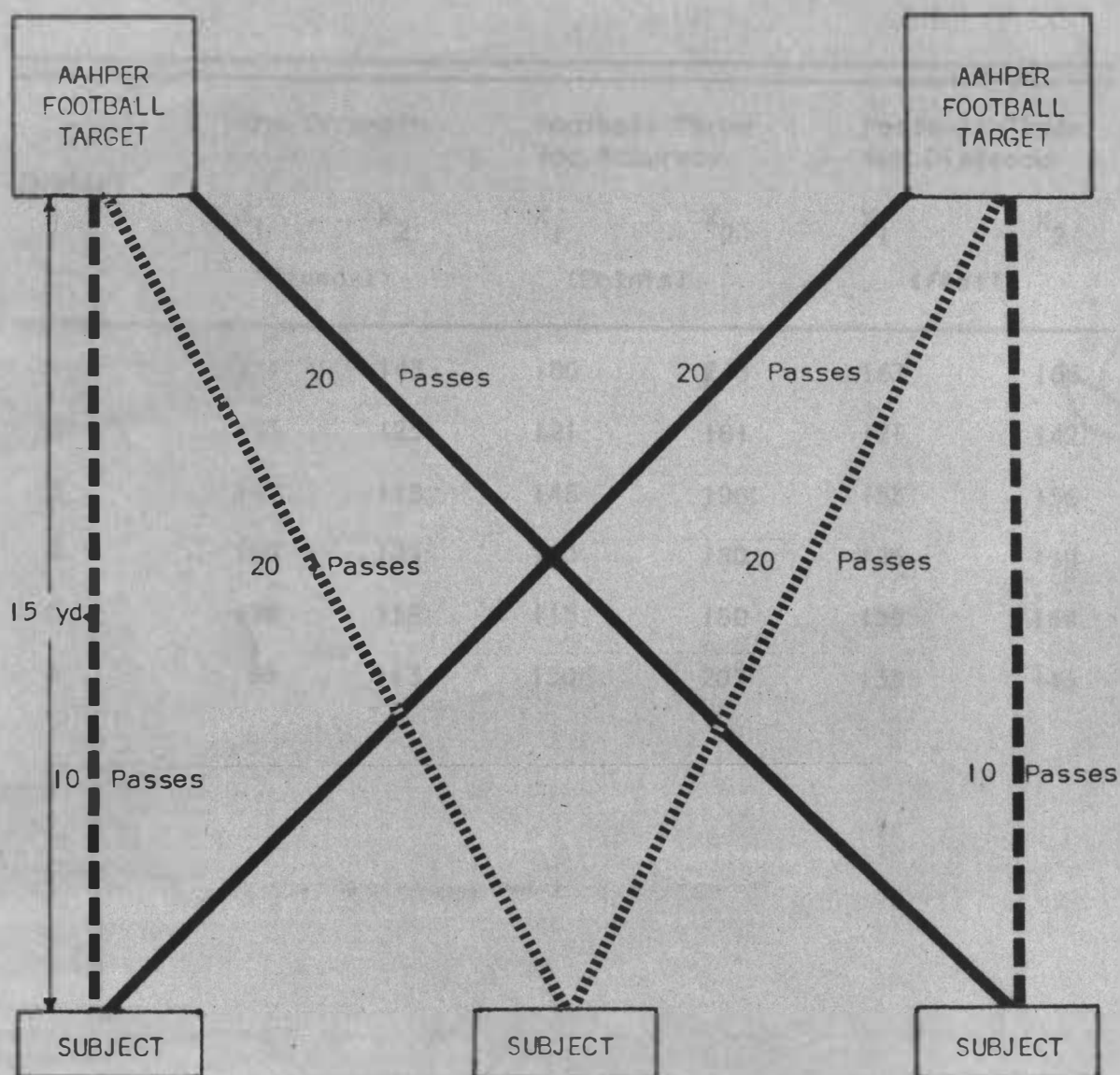
Center circle 2 feet in diameter

Middle circle 4 feet in diameter

Outer circle 6 feet in diameter

## Appendix C

## PASS PATTERNS



Appendix D  
RAW SCORES OF PRELIMINARY  
AND FINAL TESTS

Resistance Group

Subject	Arm Strength		Football Throw for Accuracy		Football Throw for Distance	
	$X_1$	$X_2$	$X_1$	$X_2$	$X_1$	$X_2$
	(Pounds)		(Points)		(Feet)	
1	111	143	180	248	163	166
2	103	125	121	181	121	142
3	107	118	148	198	153	156
4	107	125	100	180	125	139
5	128	158	115	160	150	164
6	95	113	150	207	133	145

Appendix E  
RAW SCORES OF PRELIMINARY  
AND FINAL TESTS

Throwing Group

Subject	Arm Strength		Football Throw for Accuracy		Football Throw for Distance	
	$X_1$	$X_2$	$X_1$	$X_2$	$X_1$	$X_2$
	(Pounds)		(Points)		(Feet)	
1	95	102	130	171	148	155
2	111	112	117	134	157	160
3	115	120	131	170	140	150
4	105	117	139	164	153	150
5	110	126	127	158	145	156
6	102	121	129	156	160	162